



Crossbow Technology

Smarter Sensors In Silicon

DARPA SensIT

- Company History and Overview**
- Mote Status**

January 17, 2002

Crossbow

INTELLIGENT
Sensors
CrossNet
WIRELESS



Corporate Overview

- Founded by Mike Horton and A. Richard Newton in 1995
 - » Headquarters in San Jose, CA.
 - » Founders instrumental in MEMS technology at UC - Berkeley
- Board of Directors
 - » Jerry L. Fiddler, Founder/Chair, Wind River Systems
 - » Harvey C. Jones, Chairman, Tensilica; Former CEO Synopsys
 - » Paul L. Davies III - Managing Principal, Cambria Group
 - » A. Richard Newton - Dean Engineering, UC Berkeley
 - » Michael A. Horton - Co-founder, Crossbow President/CEO
- Lead Venture Investor: Morgenthaler Ventures

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Crossbow Today

- 40 employees – San Jose CA
- Intelligent Sensors Products:
 - » Accelerometers, Tilt Sensors, Magnetometers, IMUs, Vertical Gyros, AHRS.
 - » 100,000 intelligent sensors installed in a variety of markets
- Wireless Sensor Networks:
 - » Sensor-Independent Wireless DAQ Kits—Bluetooth-Based
 - » Berkeley “Motes” Wireless Sensor Networks
- Named to Top 50 Companies To Watch: Cahners Electronics Industry’s Movers & Shakers 2000
- Two “Best Products” awards for 2001 in Sensors Magazine for Inertial and Wireless products

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Crossbow Standard Products

ProductLine	Applications	Markets
Inertial/Gyro 	• Navigation • Stabilization	• Aerospace • Military • Marine
Acceleration 	• Machine Health • Vibration Testing • General Purpose	• Factory Automation • Automotive • Smart Munitions
Tilt 	• Machine Control • Machine Safety	• Construction • Heavy Equipment
Magnetic 	• Navigation	• Drilling • Scientific Instrumentation
Wireless 	• Data Collection • Automation	• Vehicle Testing • Process Control

Inertial Products

- In 1998 Crossbow introduced the first all silicon based Inertial Measurement Unit (IMU).



Traditional Inertial Markets

Results:

- Captured design wins with top companies in existing aerospace/military market. Replaced outdated technology with improved performance/cost ratio.

NORTHROP GRUMMAN



Raytheon



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New Inertial Applications

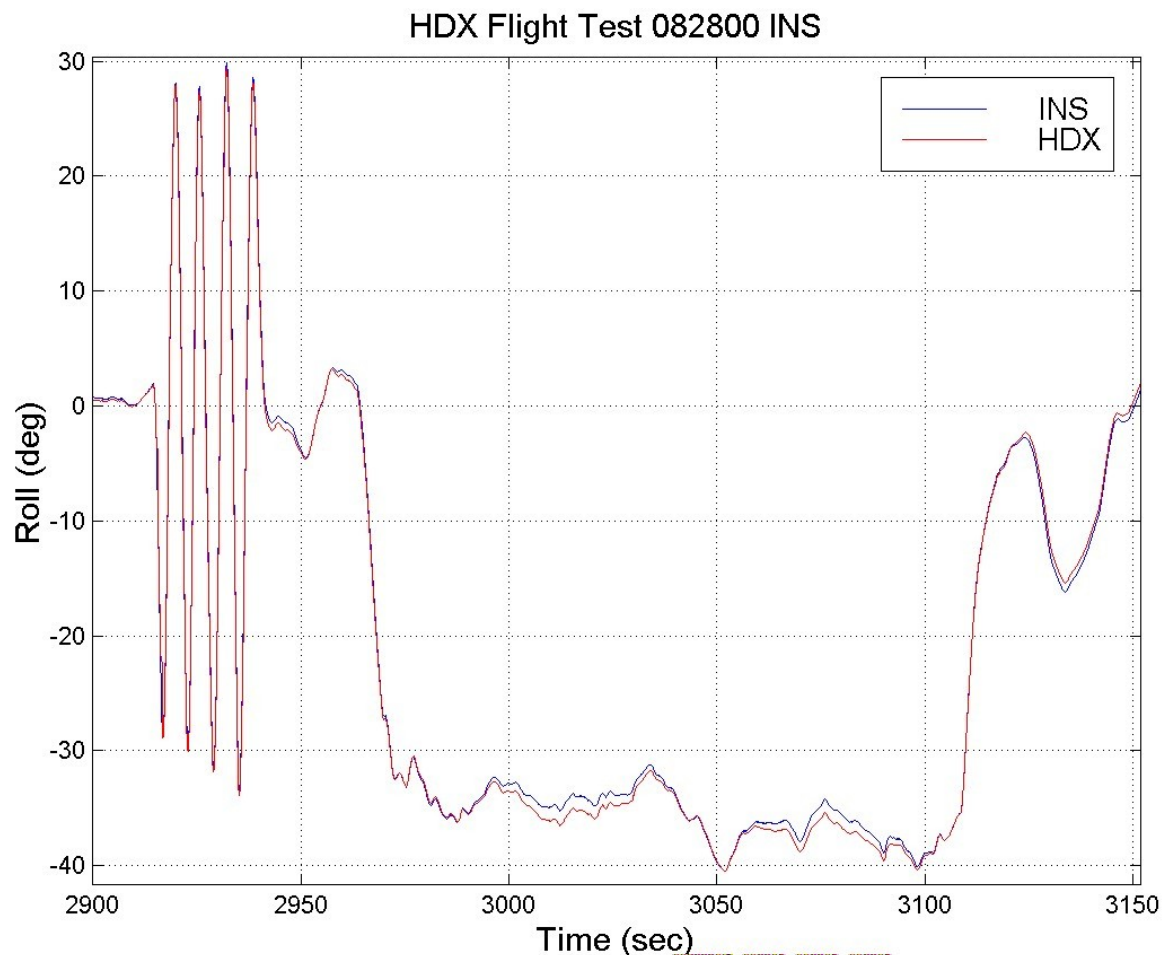
Results:

- Enabled new markets:
 - » Major partnerships in General Aviation, Automated Farming
 - » Precision guided municipal vehicles, construction equipment

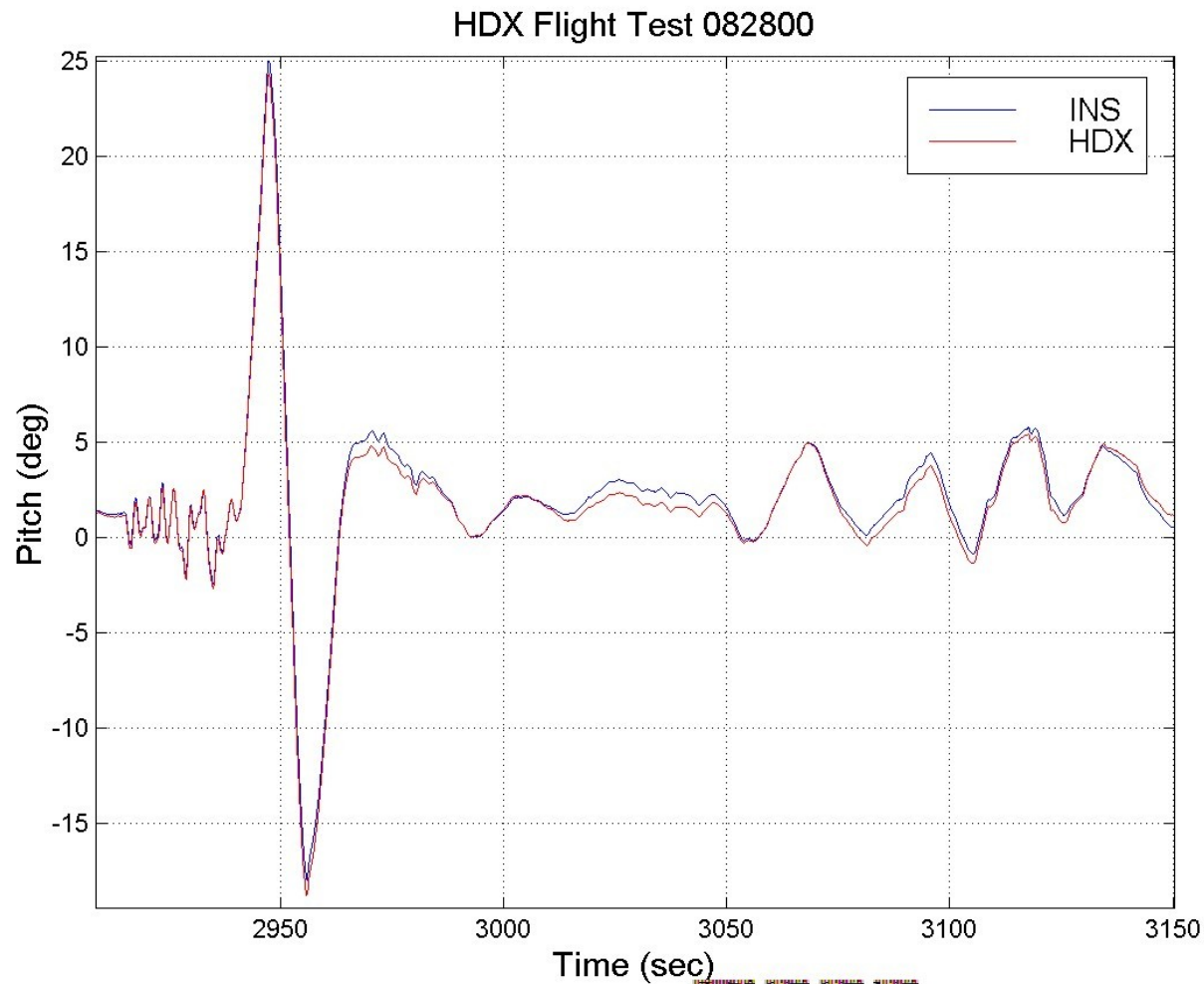


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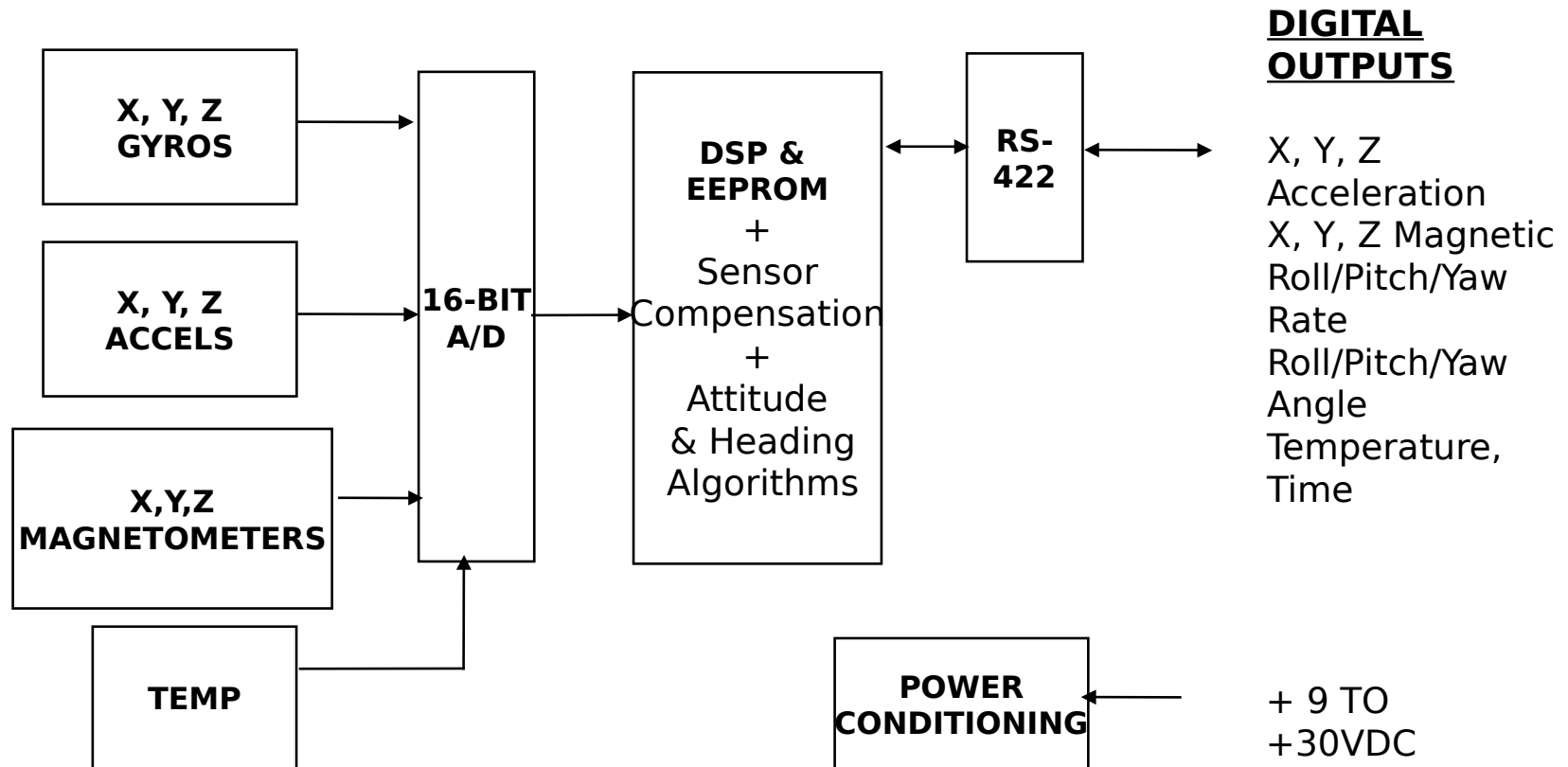
Performance High Dynamic Profile--Roll



Performance: High Dynamic Profile--Pitch



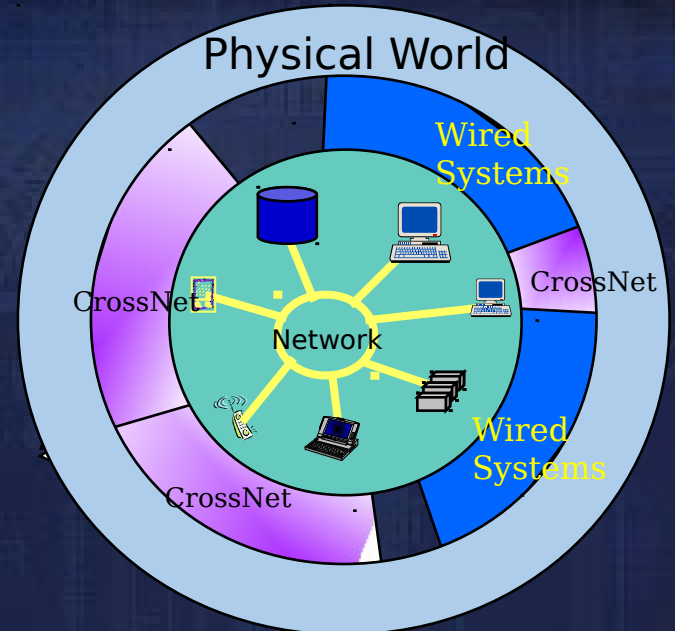
Crossbow Inertial Architecture



Wireless Sensor Networks

- **Fill The Gap**

- » Growing requirements for easy sensing and measurements
- » New computing and communications infrastructure (wireless, internet)
- » *Provide new, simple, wireless linkage between the physical world and the computer*

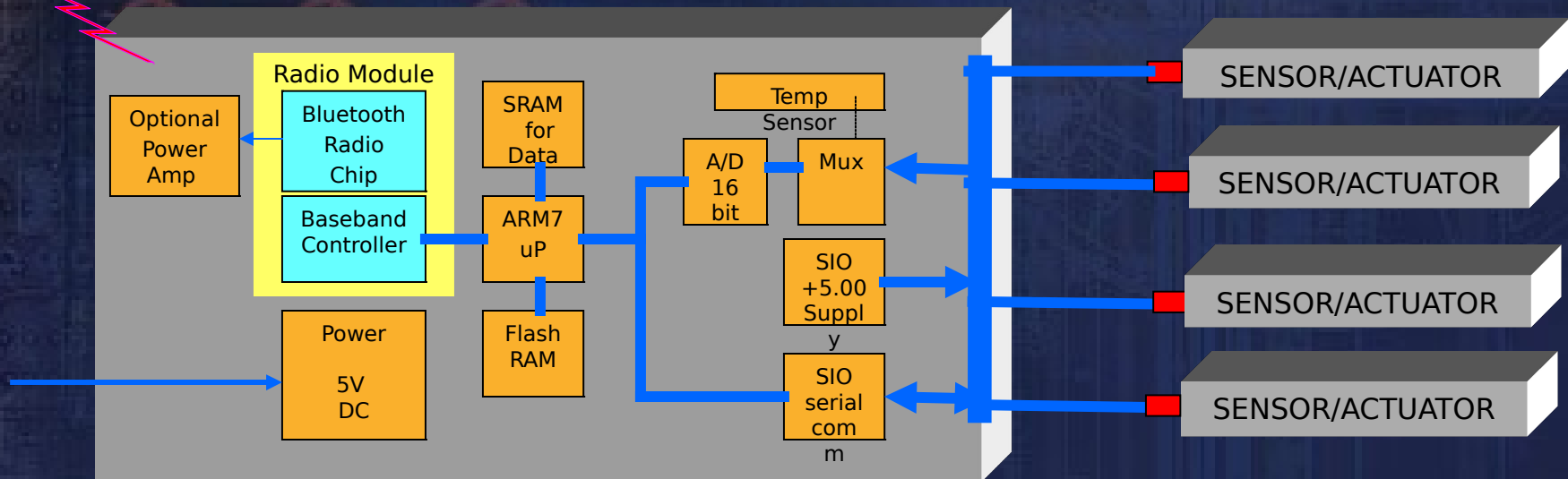


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Wireless Node Architecture

300' or 30' Range



- Wireless “plug and play” of analog sensors to digital networks
- Integrates Bluetooth and open interface standards with Crossbow sensor IP
- Local computing, control, and signal conditioning

General DAQ Network

Smart I/O

Node



**Hub:
PC Radio**



Sensor

- Target Markets: General Purpose Data Acquisition and Data Logging, Lab Environments
- Easily links existing sensors wirelessly to your PC
- 4 channel, 100m range
- Receive data on your PC using Crossbow's software
- Available now

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Markets for Wireless Sensor Networks

- Major Potential Markets:
 - » Military
 - » Machine Health Monitoring
 - » Food Storage
 - » Factory Automation
 - » Plant Automation
 - » Building Automation
 - » Automotive
 - » Security
 - » Utilities

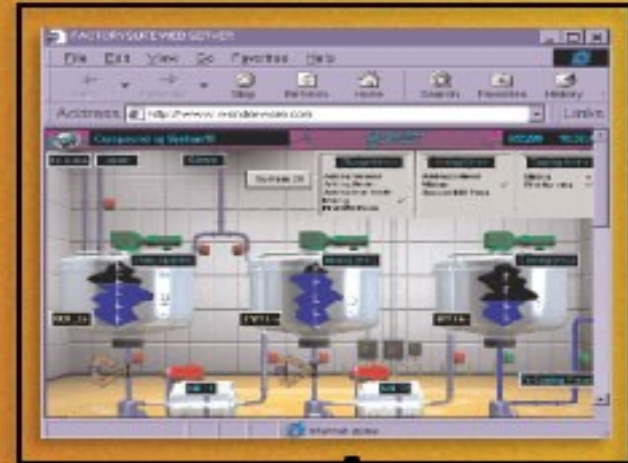
All of these industries looking at wireless technologies.

Most are slow to adopt. Very early stages. Will be a long time before wholesale shift.

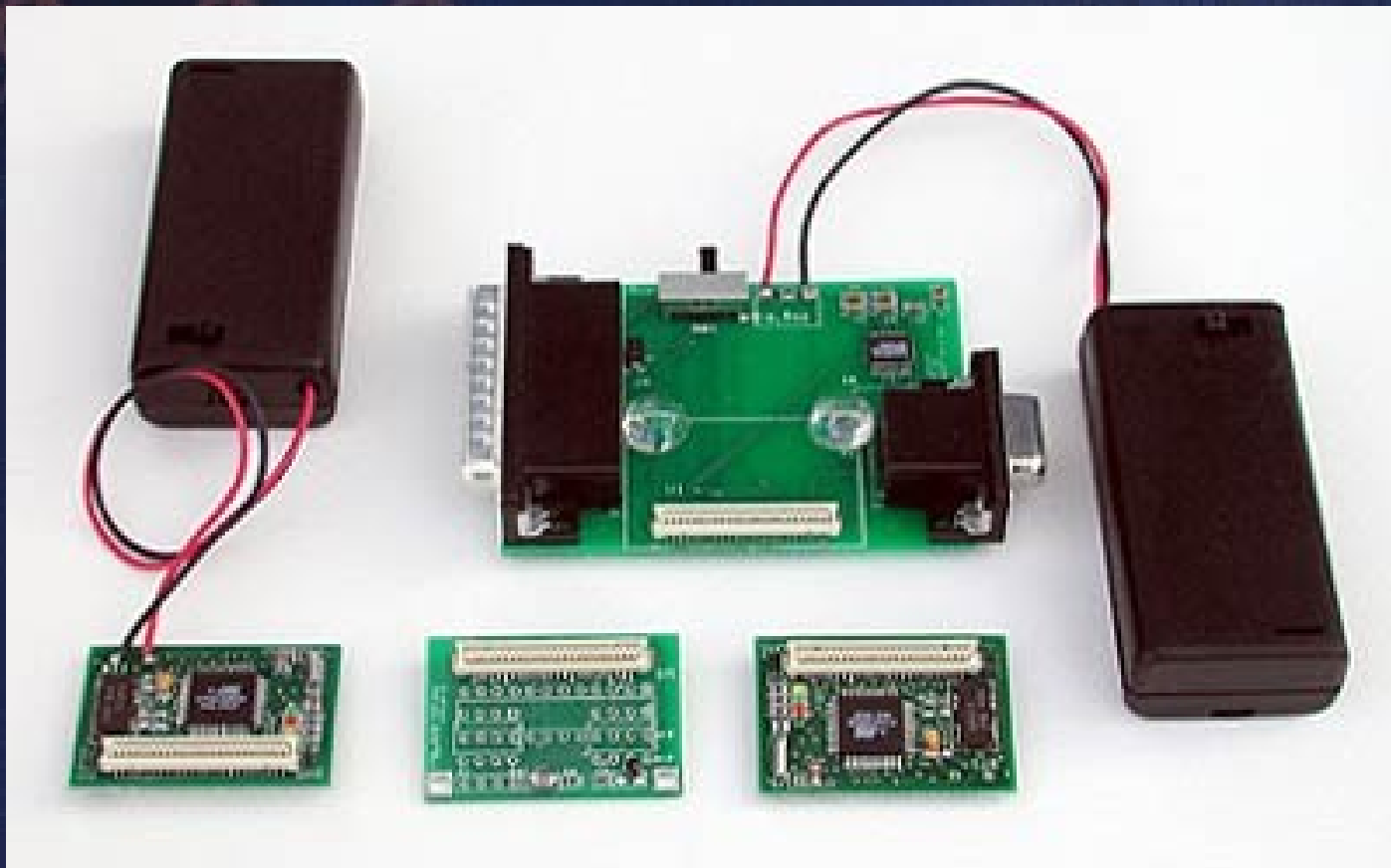
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Wireless Industrial Application Sensing/Actuation—I/F with Ctrl System



Collaboration with UC Berkeley MOTES!



Crossbow Collaboration with UCB on Rene Mote

- Provide Berkeley-designed wireless 'motes' to research community
- Seismic and Building Monitoring—Joint with UCB (EECS/CE)
 - » Deployed Network for energy monitoring—Cory Hall
 - » Deployed Network in Japanese Earthquake Study
 - » Instrumented 3-Story Building on Seismic shaker—Richmond
- Military-Use Wireless Sensor Network
 - » UCB / DARPA; deploy for various detection missions.

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MICA Motes

	Rene	MICA
Processor	4MHz	4MHz
Memory	16K	128kbytes
Antenna	add-on external	on-board antenna optional external
Radio	RFM 916MHz	RFM 916MHz
Speed	19.2Kbaud	52Kbaud
On-Board Flash	256K-bit	4M-bit
Unique ID	No	Yes

- Radio/Processor Board and PC I/F Board: Delivery March 1
- Old Light/Temp Sensor Board Compatible: Available Now
- New Sensor Board: Light, Temp, Mag, Accel, Acoustic
 - Two Versions: Fully loaded and sparsely populated
 - Probably March 15



Crossbow Mote Improvement Initiatives

- Power Management (in software)—designed
- Improved manufacturability
- Incorporate better radio technologies:
 - » robustness to interference (spread spectrum or tunable)
 - » range / power
- Better software support and documentation
- Targeted solutions, e.g., seismic, personnel detection
- ***There is no “one-size-fits-all” architecture.***
 - » ***The application drives the requirements***

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Crossbow Summary

- Market leader and innovator in Intelligent Sensors
- Market leader in MEMS-based Inertial systems
 - » UAVs, ROVs, Land vehicles, automotive test, and now General Aviation
- Strong background in qualification to Mil-std environmental and other specifications
- Initial business success with Wireless Sensor Networks
- Committed to serving the R&D community with continued collaboration and reliable wireless R&D platforms and products

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